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I also certify that the attached copy of the request for grant of a Patent (Form 1/77) bears an amendment, effected by this office, following a request by the applicant and agreed to by the Comptroller-General.

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Signed A M Brewer.

Dated 30 SEP 1997

Patents Form 1/77

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Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

1. Your reference

PT/SMC/18.9(02)

18 SEP 1996

2. Patent application number
(The Patent Office will fill in this part)

9619459.2

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

Peter Joseph JACKSON
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Patents ADP number *(if you know it)*

6633879001

If the applicant is a corporate body, give the country/state of its incorporation

4. Title of the invention

BREATHING APPARATUS

5. Name of your agent *(if you have one)*

~~G F Redfern & Company~~
~~Redfern House~~
~~149/151 Tarring Road~~
~~Worthing~~
~~West Sussex~~
~~BN11 4HE~~

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

Beresford & Co
2-5 Warwick Court
High Holborn
LONDON
WC1R 5DJ

FSI/77 26.9.97 ML

Patents ADP number *(if you know it)*

1412006

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
See note (d))

NO

Patents Form 1/77

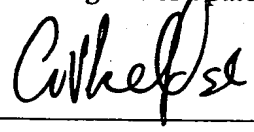
9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	-
Description	7
Claim(s)	-
Abstract	-
Drawing(s)	1

10. If you are also filing any of the following, state how many against each item.

Priority documents	-
Translations of priority documents	-
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	-
Request for preliminary examination and search *(Patents Form 9/77)*	-
Request for substantive examination *(Patents Form 10/77)*	-
Any other documents *(please specify)*	-

11. I/We request the grant of a patent on the basis of this application.

Signature  Date 17 September 1996

12. Name and daytime telephone number of person to contact in the United Kingdom

Paul Topley
01903 820466

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Notes

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BREATHING APPARATUS

This invention relates to breathing apparatus whereby breathable gas is supplied automatically to the wearer in accordance with his respiratory requirements. More particularly, it relates to apparatus of the 'Positive Pressure' type, wherein a pressure which is a predetermined level above ambient is maintained within the facepiece so as to prevent inward leakage of air or smoke, etc., from the surrounding atmosphere into the interior of the facepiece.

Breathing apparatus of the positive pressure type is well known, and is commonly used by firefighters for entering smoke-filled buildings or while dealing with chemical spills. For these purposes, it is normal to use apparatus of the self-contained type where a supply of air is carried by the wearer in one or more high pressure cylinders.

A typical apparatus comprises of a cylinder containing compressed air at high pressure, typically 200 to 300 bar, which is carried on the wearer's back by means of a backplate or frame, to which is attached an adjustable webbing harness. The cylinder is fitted with a stop valve, to which is connected a pressure regulating valve which reduces the air supply pressure to a substantially constant value of, say, 7 bar. The air Is supplied by this first stage regulator, via a flexible hose, to a second stage regulator, commonly known as a demand valve, which is attached to a full facepiece of rubber or a similar resilient material, held to the wearer's face in a leak-tight manner by means of an adjustable head harness.

The facepiece, which has a transparent visor, is fitted with a non-return valve through which the wearer's exhaled breath is exhausted to atmosphere. This valve is spring loaded so as to open only when pressure within the facepiece exceeds the predetermined level above that of the surrounding atmosphere, this difference normally being set at about 4 millibar.

The demand valve responds to pressure changes within the facepiece and is spring loaded or biased so as to open and admit air from the first stage regulator when pressure within the facepiece falls, due to

inhalation by the wearer or outward leakage, to a level below, say, 3 millibar above the ambient outside pressure. By this means, pressure within the facepiece is maintained at a level of between 3 and 4 millibar above the ambient outside pressure.

In order to allow a fully attired wearer to breathe atmospheric air in areas where it is safe to do so, and thus conserve his limited air supply, and also to facilitate decontamination of the facepiece after use, the connection between the demand valve and the facepiece is commonly by means of a bayonet or similar coupling which can be rapidly assembled or disassembled by the wearer.

The facepiece is also conventionally fitted with a speech transmission diaphragm, comprising of a taut membrane of thin metal or high strength plastics material, supported in a rigid housing in the front of the facepiece and protected by a grille. The clear transmission of speech is of critical importance in many situations in which breathing apparatus is worn, particularly in firefighting.

It is also conventional to provide a gauge to indicate the air pressure in the cylinder, in order to allow the wearer to monitor his air supply. An audible alarm, usually a whistle or bell, indicates when cylinder pressure has fallen to or below a predetermined level.

The typical apparatus described above has a number of limitations and disadvantages, which the present invention seeks to overcome.

The facepiece, incorporating the speech transmission diaphragm, spring loaded exhalation valve and connection for the demand valve, is a complex assembly of many parts and is thus costly to produce. Its cost inhibits the provision of personal facepieces to individuals, giving rise to objections relating to communicable diseases and necessitating very thorough decontamination after every use. The demand valve, which is in the respiratory circuit and thus also susceptible to contamination, is not easy to clean effectively, due to the need to prevent the ingress into the passages in the valve of water which may subsequently freeze, adversely affecting its operation.

The necessity, for firefighters in particular, to be completely attired in their protective clothing and equipment prior to entering an area where respiratory protection becomes necessary, requires that the demand valve be disconnectable from the facepiece to allow the wearer to breathe atmospheric air whilst conserving his compressed air supply. This procedure, in turn, necessitates that an additional device be incorporated into the demand valve to override its positive pressure operation so as to prevent free escape of air and to restore demand operation when the valve is reconnected to the facepiece or when the wearer first inhales from the valve.

Disconnection of the demand valve from the facepiece exposes the outlet of the valve to the ingress of dirt or water which may later affect operation of the valve, or may be inhaled by the wearer. The demand valve, being mounted externally to the facepiece, is exposed to extremes of temperature and forms a significant protrusion which is susceptible to catching on obstructions with the subsequent risk of dislodging the facepiece.

It is the object of the present invention to overcome the disadvantages described by providing a single integrated assembly incorporating the demand valve, exhalation valve and speech transmission diaphragm with a means of allowing the wearer to conserve his air supply and breathe from the atmosphere at will without removing the assembly from the facepiece. The assembly may thus be permanently, or semi-permanently attached to the facepiece, greatly increasing the integrity of the apparatus and reducing the overall size, weight and cost due to the reduced number of component parts.

It is a further object of the invention to provide a fixed and minimal differential between the opening pressure of the exhalation valve and the opening pressure of the demand valve, and to further reduce the overall work of breathing for the wearer by providing an exhalation valve of considerably greater area than could normally be accommodated in a conventional apparatus. The invention also places the working parts of the breathing valves within the facepiece where they are protected from extremes of temperature and also provides a means of preventing ingress of

water into the demand valve, so that the complete facepiece and valve assembly may be readily washed and decontaminated by immersion.

An embodiment of the invention will now be described in detail, with reference to the accompanying drawings, in which:

Figure 1 shows a sectional side elevation of a preferred embodiment of the invention.

Referring now to the Figure, a speech transmission diaphragm assembly 1, comprises a taut membrane 2 held in a rigid circular housing 3. This diaphragm assembly 1 is rigidly fixed to a lever 4, pivoted at 5 and biased by a spring 6 such that the diaphragm closes against a deformable resilient seal 7, clamped at its periphery to a housing 8. The seal 7 is so configured that it can, after making sealing contact with the diaphragm, allow further 'inward' movement of the diaphragm (towards the wearer), beyond the initial 'closed' position seen in the Figure. The force of the spring 6 is such as to urge the diaphragm to close the opening defined by the seal 7, and is sufficient to deform or deflect the seal 7 further, beyond this initial 'closed' position.

A lever 9 is pivoted at 10 and is biased by a light spring 11 so as to close off a small pilot jet 12. When the pilot jet 12 is closed by the lever 9, the pressure within a pilot chamber 13, resulting from air entering the chamber 13 from an air inlet 14 through a metering orifice 15 in the centre of a resilient disc 16, clamps the disc 16 against a face of a flange 17. Any escape of air through the pilot jet 12 causes a reduction in pressure within the chamber 13, allowing the resilient disc 16 to bow away from the flange 17 under the influence of air pressure at the inlet 14, exposing a series of openings 18 in the flange through which air may pass from the inlet 14 to an outlet 20 and thence into the interior of the facepiece. The end of lever 9 is so positioned that 'inward' movement of the diaphragm 1, beyond the position at which it initially closes against the seal 7, will cause the diaphragm to come into contact with the end of lever 9, and pivot the lever away from the pilot jet 12, allowing air to escape through the jet 12 from the pilot chamber 13.

A resilient non-return flap 19, which protects the valve outlet 20 and the pilot jet 12 from the ingress of water, deflects to allow air to pass freely from the valve into the facepiece.

It will be understood from the foregoing that the supply of air to the facepiece is controlled by a two-stage main valve composed of the resilient disc 16, whose opening and closing is in turn controlled by the opening and closing of a pilot arrangement, composed of the pilot chamber 13 and jet 12. The pilot arrangement is in turn controlled by the movement of the lever 9, which is moved by the diaphragm 1 when diaphragm 1 moves inwards in response to a reduction in pressure within the facepiece.

When the facepiece is sealed to the wearer's face, initially no pressure difference exists between the interior of the diaphragm and the outside atmosphere. The diaphragm 1 is urged inward by the biasing spring 6. Seal 7 is deformed as diaphragm 1 moves inward under the action of spring 6. Diaphragm 1 contacts and moves lever 9 to open the pilot valve 12 and admit air to the facepiece until the pressure within the facepiece rises to a superatmospheric level sufficient to urge the diaphragm 1 slightly outwards against the force of spring 6, releasing lever 9 and allowing the pilot valve to close. A state of equilibrium will then exist if pressure within the facepiece is maintained at this level.

When the wearer inhales, pressure within the facepiece falls below the equilibrium level, the diaphragm 1 will move inwards under the action of spring 6, deflecting the resilient seal 7 and opening the pilot valve 12 to admit air to the facepiece. When inhalation ceases, pressure within the facepiece will rise again, urging the diaphragm 1 outwards, restoring the equilibrium pressure level and allowing the pilot valve 12 to close. The diaphragm remains tightly closed on the seal 7 throughout the inhalation phase.

When the wearer exhales, pressure within the facepiece will rise above the equilibrium level, and this pressure difference across diaphragm 1 urges the diaphragm outwards away from the resilient seal 7 to expose a gap around the periphery of the diaphragm 1, through which the excess air is vented to atmosphere. A cover 21, which is shown in dotted lines,

protects the assembly from damage and from radiant heat, and has suitably positioned openings (not shown) to allow for the unhindered passage of the exhaled air to atmosphere. These openings also provide a path for sounds transmitted through the diaphragm 1, allowing the clear transmission of speech.

In order to allow the wearer to breathe atmospheric air without removal of the facepiece, a lifting and latching means is preferably provided to move the diaphragm 1 away from the resilient seal 7, and to hold it in this open position. This opens a port of substantial area, directly in front of the wearer's nose and mouth. A catch may be arranged to hold the diaphragm 1 in the open position until tripped by a single action, such as by pressing a projecting button, whereupon normal biasing of the diaphragm 1, and thus normal operation of the demand valve, is restored. In order to prevent inadvertent or accidental opening of the diaphragm, the latching means is preferably designed so that a double action is required by the wearer to engage the latch, such as by simultaneously depressing two buttons on opposite sides of the valve assembly. When the diaphragm 1 is in the open position, it is necessarily out of contact with lever 9, and thus the pilot valve 12 remains closed, conserving the air supply. The wearer may then remove the facepiece without loss of pressurised air through the demand valve.

A manually operated bypass, or override, valve (not shown) may be provided, whereby a controlled flow of air may be admitted to the facepiece at will. Additionally or alternatively, a stop valve may be provided between the pressurised air supply tank and the facepiece, since it will be appreciated that if the wearer removes the facepiece without latching the diaphragm 1 open, the diaphragm 1 will be moved by the spring 6 to open the pilot valve 12 and allow a free flow of air.

The facepiece may be a simple assembly of a clear plastics visor 22, attached around its periphery to a resilient seal 23 and secured to the wearer's face by means of an adjustable head harness (also not shown). An opening in the visor 22 accommodates the integrated valve assembly previously described, which may be secured in the opening by means of screws or clips. In the preferred embodiment of the invention shown, the facepiece is provided with an inner half-mask 24.

Air entering the facepiece from the valve outlet 20 is directed into the upper area of the visor and passes through non-return flaps 25 into the half-mask 24, to be inhaled by the wearer. Exhaled air passes directly to atmosphere around the diaphragm 1, which is situated in front of the wearer's mouth for optimum speech transmission. This circuitous passage of the air through the facepiece prevents misting of the visor, ventilates the upper area of the wearer's face and minimises the amount of carbon dioxide inhaled by the wearer.

It is envisaged that the components of the demand valve may be moulded from plastics materials, to reduce weight and cost.

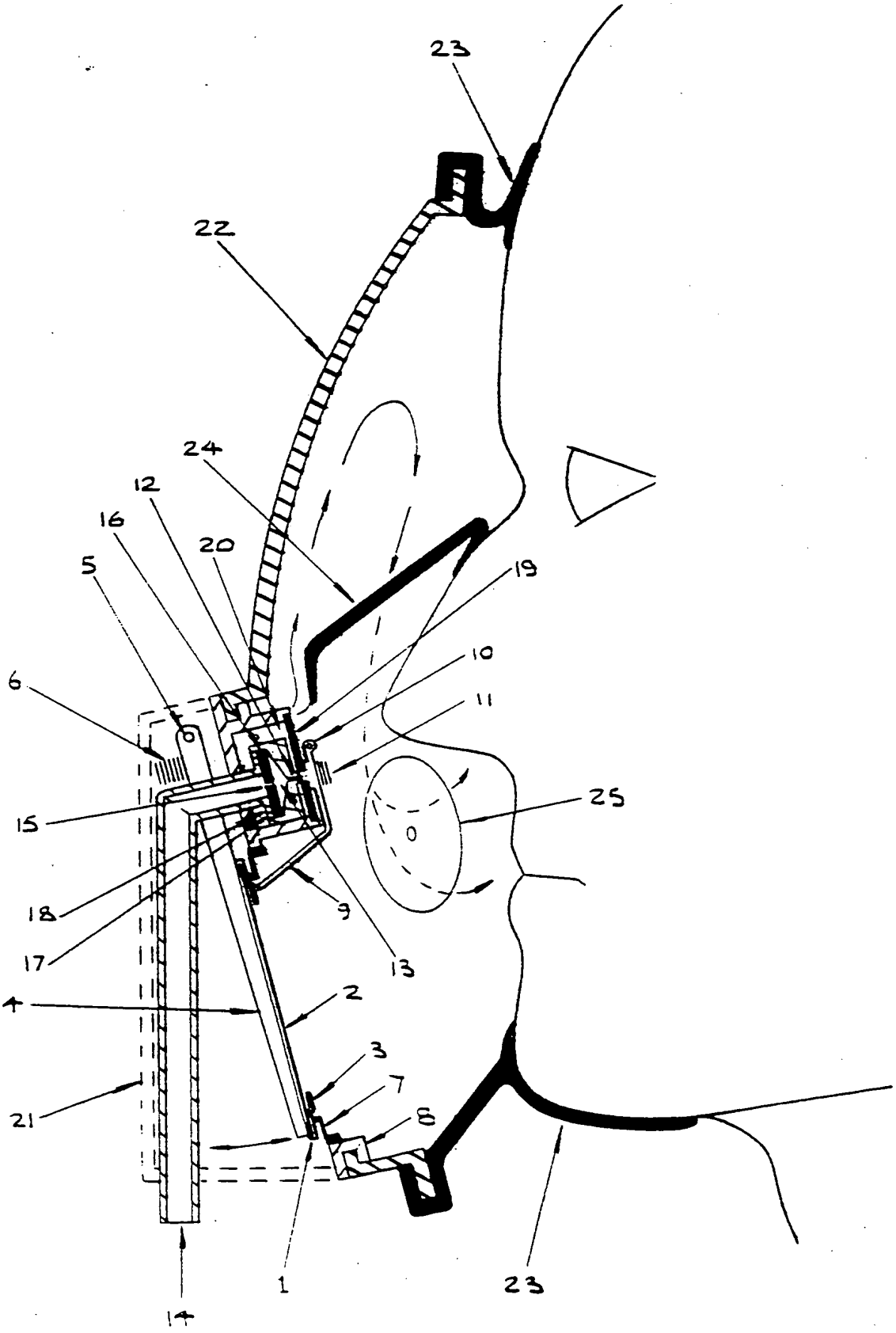

FIG. 1